タイ王国
潤滑油製造プラント
建設計画調査
報告書

(付　録)

1984年12月

国際協力事業団

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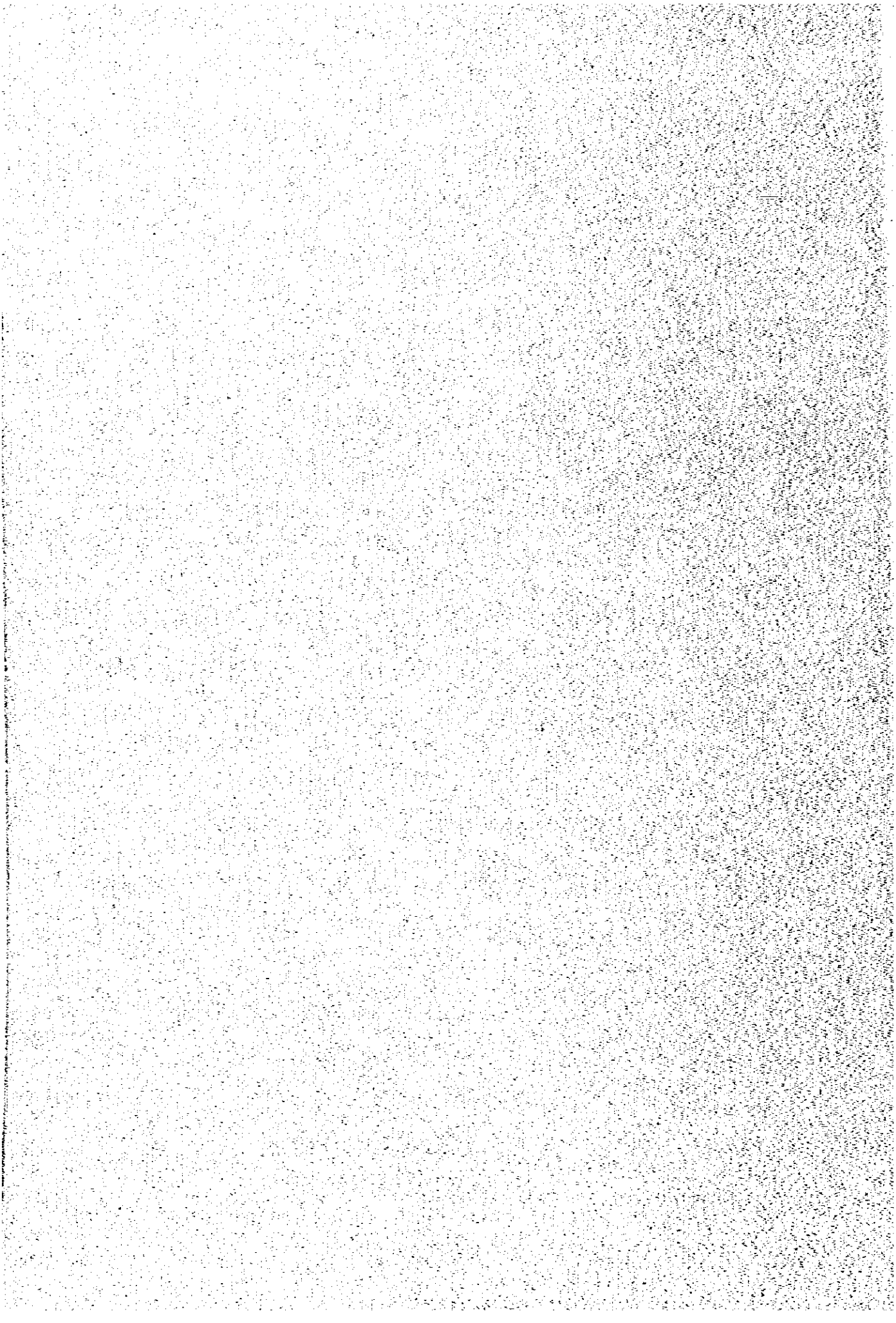
LIST OF ANNEXES

ANNEX II

ANNEX II-1

MARKET STUDY OF THE LUBRICATING OIL



CONTENTS

1 Vehicles (Transportation on Road)

Data of vehicles is shown in Table AII-1-1(1) to (6).

2 Transportation

2-1 Railway

NUMBER OF DIESEL LOCOMOTIVES AND LUBE OIL CONSUMPTION IN THAILAND IN 1983 AND 1993

	Number of Diesel Locomotives	Engine Oil (kl)	Grease[3] (kl)	Total (kl)
1983	272[1]	1,590[1]	0.03[1]	1,590.03
1993	504[2]	2,945	0.05	2,945.05

Notes: 1) Source: State Railway of Thailand

2) Average annual growth rate in estimated as follows which is the same of estimated growth rate of GDP. (Hereafter referred to as growth rate of GDP)
   1983 - 1986 6%
   1987 - 1993 6.5%

3) Unit of grease is ton, but the consultant estimate that ton is equal to kl.

2-2 River Transportation by Self Propelled Vessels

NUMBER OF VESSELS AND LUBE OIL CONSUMPTION

	Number of Vessels	Engine Oil (kl)	Industrial Oil (kl)	Total (kl)
1983	10,508[1]	53[3]	4[3]	57
1993	12,809	63	5	68

Notes: 1) Source: Calculated from Kaiji Kokusai Kyoryoku Center (hereafter referred to as KKKC) data in 1981.

2) Average annual growth rate is assumed to be 2% by the consultant.

3) Units lube oil consumption are estimated as follows from the experiences in Japan.
   Engine oil consumption 5 lit/unit.year
   Gear oil consumption (Industrial oil) 0.4 lit/unit.year

2-3 River Transportation Except Self Propelled Units

(1) Tonnage of Vessels in 1981

144,500 ton

Source: KKKC

(2) Preconditions of Base Oil Consumption in 1981

1. Distance of navigation (Source: KKKC)

The Cho Phrayo River: Gulf of Thailand-Nakon Sawan 380 km

The Nan River: Nakon Sawan-Uttaradit 370km

One navigation is estimated by the consultant as follows: (380km+270km)/3=217km

2. Horse power of total vessels (Source: KKKC)

Horse power of total vessels is 144,500sp which is same as the tonnage.

3. Navigation hours per one voyage is as follows:

217km / (5kn x 1.852km) x 2 = 46.8hours (two ways)

5kn is the speed of vessel.

4. Number of Voyages

4days for loadings and unloading of goods.

365days/(4+2)days x 50%=30voyages

50% is the operating ratio.

5. Lube oil consumption by unit

0.35cc/HP.hr

Estimated by the consultant from the experience in Japan.

(3) Lube Oil Consumption in 1981

0.35cc/HP.hr x 144,500HP x 46.8hr x 30 voyages=71kl

Hereafter, lube oil consumptions of barge and ship are calculated by the same say.

Engine oil	71kl x 80% = 57kl
Marine cylinder oil (Industrial oil)	71kl x 20% = 14kl

80% and 20% are estimated by the consultant from vessel size which was estimated by KKKC.

(4) Lube Oil Consumption in 1983 and 1993

	Total Tonnages	Engine Oil	Marine Cylinder Oil (Industrial Oil)	Total (Kl)
1981	144,500	57	14	71
1983	150,338	59	15	74
1993	183,261	72	18	90

Note: Average annual growth rate is estimated to be 2% by the consultant.

2-4 Coastal Transportation Except Petroleum

(1) Preconditions of Lube Oil Consumption in 1981

1. Distance of one navigation

Bangkok - Sattaheep	200 km
Bangkok - Song Khla	355 km

2. Horse power of total vessels to Sattaheep and Song Khla

Total DWT for coastal transportation 447,000 DWT
(Source: KKKC)

Total tonnage is segregated by both populations.

To Sattaheep 447,000DWTx37%=165,390DWT=165,390HP
To Song Khla 447,000DWTx63%=281,610DWT=281,610HP

3. Navigation and loading and unloading days

To Sattaheep

Navigation 200km/(5knx1.852km)x2=43hr=2days
Loading and unloading 3days
Total 5days

To Song Khla

Navigation 355km/(5knx1.852km)x2=77hr=4days
Loading and unloading 3days
Total 7days

Note: 5kn is the speed of vessel.

4. Number of voyages

To Sattaheep

365days/5days x 50% = 36.5voyages

To Song Khla

365days/7days x 50% = 26.1voyages

Note: 50% is operating ratio

5. Lube oil consumption by unit

0.35cc/HP.hr

Estimated by the consultant from the experience in Japan.

(2) Lube Oil Consumption in 1981

To Sattaheep	91kl
To Song Khla	198kl
Total	289kl

	in 1981 (kl)	in 1983 (kl)
Engine oil	289x34%= 98	$98x(1.04)^2$=106
Marine cylinder oil (Industrial Oil)	289x66%=191	$191x(1.04)^2$=207

Note: The rate of 34% and 66% are estimated based on ship size.

(3) Lube Oil Consumption in 1983 and 1993

Average annual growth rate is estimated 4% by the consultant.

	Tonnage (1,000 ton)	Engine Oil (kl)	Marine Cylinder Oil (Industrial Oil (kl)	Total (kl)
(1981	447	98	191	289)
1983	483	106	207	313
1993	715	157	306	463

2-5 Crude Oil Import

(1) Lube Oil Consumption for Crude Oil Import in 1982

Lube oil consumption for crude import in 1982 is shown in Table AII-1-2.

(2) Lube Oil Consumption (Supplied by Thailand) for Crude Oil Import in 1983 and 1993.

	1983		1993	
Import Crude Oil (10^3kl)	9,226		13,669	
Import Crude Oil for which Thailand Supplies Cons. Lube Oil (10^3kl)	9,101[2]		2,974[3]	
Marine Cylinder Oil (kl)[4]	192.0	194.0	14.4	14.5
Other Industrial Oil[5]	2.0		0.1	
Grease (kl)[6]	0.2		0.01	
Total (kl)	194.2		14.51	

Note: 1) Source: Table AII-1-2.

2) Import crude oil except China for which Thailand supplies consumed lube oil.

3) Import crude oil except China and Middle East for which Thailand supplies consumed lube oil.

4) Estimated by Table AII-1-3.

4) and 5) are industrial oil.

5) 6) Estimated 1% on marine cylinder oil is other industrial oil and 0.1% is grease.

2-6 Crude Oil Transportation from Sri Racha to MOR

MOR receives import crude oil in Sri Racha tank yard, then the crude oil is transported to MOR by small tanker.

	Crude Oil (10^3kl)	Marine Engine Oil (Industrial Oil) (kl)
(1982	2,852[1])	8[3])
1983	2,852[2]	8
1993	3,371[2]	9

Notes: 1) Source: OIL AND THAILAND 1982

2) Estimated from CRUDE OIL TOPPING CAPACITY (Source: NEA)

3) Tanker size 25,000DWT, Horse power 17,600sp Speed 5kn, Distance 65nm; Unit lube oil consumption is 1.16cc/HP.hr.

2-7 Petroleum Products Import (Fuel, Lube Oil and Base Oil)

Fuel means LPG, gasoline, jet fuel, kerosene, diesel oil and fuel oil (except lube oil, wax and others).

(1) The Import products for which consumed lube oil supplied by Thailand in 1982 are shown in Table AII-1-4.

(2) The consumed lube oil which is supplied by Thailand for products import in 1982 is shown in Table AII-1-5.

(3) Lube Oil Consumption (Supplied by Thailand) for Product Import in 1983 and 1993

	1982	1983	1993	
Import Products (10^3kl)[1]	2,476	2,645	4,883	
Marine Cylinder Oil (kl)[4]	51.1[2]	54.6	53.2[3]	
(Industrial Oil)				53.7
Other Industrial Oil[4] (Industrial Oil)	0.5	0.5	0.5	
		55.1		
Grease (kl)	0.05	0.05	0.05	
Total	51.65	55.15	53.75	

Notes: 1) Source: Table AII-1-3. Fuel Import (1)+ Lube oil (4) + Base Oil import.

2) Source: Table AII-1-4.

Consumed lube oil supplied by Thailand is to be assumed by the consultant as follows:

in 1983	Middle East	100%
	China	0%
	Other Countries	50%

3) Consumed lube oil supplied by Thailand is as follows:

in 1993	Middle East	0%
	China	0%
	Other Countries	50%

4) Industrial Oil

2-8 Petroleum Products (Fuel) Transportation from Sri Racha to Bangkok

(1) Precondition to be Assumed by the Consultant

1. Import fuel: MOR - Received in his depots.

TORC and Esso

1/2 Received in their depots.

1/2 Received in their refineries.

2. TORC and Esso transport 85% of import fuel which is received in their refineries and produced products from Sri Racha to Bangkok by sea.

3. Total DWT: 1,452 (answer of Company A),
Horse power: 1,452sp
Carring capacity: 1,400kl, Speed: 5kn,
Distance (from Sri Racha to Bangkok): 70nm,
Unit lube oil consumption in average: 0.255cc/HP.hr
(By the experience in Japan)

(2) Transportation Volume of Fuel from Sri Racha to Bangkok

(Unit: 1,000 kl)

	Fuel Import (1)	TORC and Esso Fuel Import (2)	(2)x1/2 (3)	TORC and Esso Fuel Production (4)	(3)+(4) (5)	(5)x85% (6)
1982	2,314	1,556	778	6,066[1)]	6,844	5,817
1983	2,467	1,659	830	6,066	6,896	5,862
1984	2,518	1,694	847	6,066	6,913	5,876
1985	2,043	1,366	683	6,495	7,178	6,101
1986	1,572	1,045	523	6,925	7,448	6,331
1987	1,555	1,064	532	7,553	8,085	6,872
1988	2,183	1,493	747	7,553	8,300	7,055
1989	2,843	1,945	973	7,553	8,526	7,247
1990	1,316	971	486	9,824	10,310	8,764
1991	2,045	1,509	755	9,824	10,579	8,992
1992	3,403	2,511	1,256	9,824	11,080	9,418
1993	4,883	3,603	1,802	9,824	11,626	9,882

Notes: (1) Source: 3) of Table AII-1-5.

(2) Fuel oil import by TORC and Esso is Their corresponded to their CRUDE OIL TOPPING CAPACITY to be assumed. (Source: EMP)

(3) 1/2 of import fuel is received in refineries, another 50% is received in their depots.

(4) 1) Source: "OIL AND THAILAND 1982" After 1983, these are corresponded to CRUDE OIL TOPPING CAPACITY to be assumed. (Source: EMP)

(6) 85% of imported and produced products of TORC and Esso is transferred from Sri Racha to Bangkok by sea, which is surveyed by the consultant.

(3) Lube Oil Consumption in 1983 and 1993

(Unit: 1,000 kl)

	Transport Product[1]	Engine Oil[2]	Marine Cylinder Oil (Industrial Oil)[2]	Grease[3]	Total
1983	5,817	21.5	21.5	0.04	43.04
1993	9,882	36.0	36.0	0.07	72.07

Notes: 1) Source: Above Table.

2) 50% of lube oil consumption is engine oil and another 50% is marine cylinder oil, assumed by the consultant due to transportation vessel sizes.

3) It is assumed that 0.01% of lube oil consumption is grease consumption.

Reference: Base oil plant is not decided, so lube oil consumption for base oil transportation from the base oil plant to the blending plant can not be estimated, but it is very small.

CONCLUSION "2" TRANSPORTATION

LUBRICATING OIL CONSUMPTION (1)
TRANSPORTATION

		Answer for Questionnaire					1 9 8 3					Average Growth Rate (1983-1993)
			Lubricating Oil Consumption (kl)					Lubricating Oil Consumption (kl)				
		Production	Engine Oil	Industrial Oil	Grease	Total	Production	Engine Oil	Industrial Oil	Grease	Total	
2-1	Railway	272 cars	1,590		0.03	1,590.03	272 Cars	1,590.0	-	0.03	1,590.03	Growth Rate of GDP
2-2	River Trans. Propelled		N.A.[2]				10,508 vessels	53.0	4.0	-	57.0	2
2-3	River Trans. Ex. Propelled		N.A.				150,338 tonnages	59.0	15.0	-	74.0	2
2-4	Coastal Trans. Ex. Petroleum		N.A.				483,000 tonnages	106.0	207.0	-	313.0	4
2-5	Crude Import		N.A.				9,226,000 kl	-	194.0	0.20	194.2	
2-6	Crude[1] Trans. for MOR		N.A.				2,852,000 kl	-	8.0	-	8.0	
2-7	Petroleum Prod. Import		N.A.				2,645,000 kl	-	55.1	0.05	55.15	
2-8	Petroleum Prod. Trans. Sri Racha to Bangkok		N.A.				5,817,000 kl	21.5	21.5	0.04	43.04	
	Total							1,829.5	504.6	0.32	2,334.4	

Notes: 1) MOR receives import crude oil in Sri Racha tank yard them transports to MOR.

2) N.A.: not available.

LUBRICATING OIL CONSUMPTION (2)
TRANSPORTATION

		1993				
		Production	Lubricating Oil Consumption (kl)			
			Engine Oil	Industrial Oil	Grease	Total
2-1	Railway	504 cars	2,945.0	-	0.05	2,945.05
2-2	River Trans. Propelled	12,809 vessels	63.0	5.0	-	68.0
2-3	River Trans. Ex. Propelled	183,261 connages	72.0	18.0	-	90.0
2-4	Coastal Trans. Ex. Petroleum	715,000 connages	157.0	306.0	-	463.0
2-5	Crude Import	2,974,000 kl	-	14.5	0.01	14.51
2-6	Crude Trans. for MOR	3,371,000 kl	-	9.0	-	9.0
2-7	Petroleum Prod. Import	4,883,000 kl	-	53.7	0.05	53.75
2-8	Petroleum Prod. Trans. Sri Racha to Bangkok	9,882,000 kl	36.0	36.0	0.07	72.07
			3,273.0	442.2	0.18	3,715.4

3 Agriculture, Fishery, Forest and Cold Storage

3-1 Agriculture

(1) Agriculture Machinery in Use and Average Growth Rate:
See Table AII-1-6

(2) Estimated Number of Agriculture Machineries From 1983 To 1993:
See Table AII-1-7

(3) Estimated Lube Oil Consumption By Agriculture Machineries:
See Table AII-1-8

3-2 Fishery

(1) Fish Captured

Estimated quantity of fish captured for the following period in Thailand is shown below.

(Unit: ton/year)

Fish Captured	1982	1983	1985	1990	1995
Marine	1,861,000	1,800,000	1,500,000	1,560,000	1,560,000
- In Thai Therritorial Waters	1,761,000	1,700,000	1,400,000	1,450,000	1,450,000
- Out of Thai Territorial Waters	100,000	100,000	100,000	110,000	110,000
Inland	134,000	159,000	197,000	200,000	200,000
Total Quantity of Fish Captured	1,995,000	1,959,000	1,697,000	1,760,000	1,760,000

Source: Ministry of Agriculture and Cooperatives, Department of Fisheries

(2) Lube Oil Consumption

Lube oil consumption for fish captured in Thailand is not available, so the Consultant estimate by using Japanese data (source: the Japanese Government and Japanese company).

Total lube oil consumption: 4.51kl/1,000 ton

Breakdown
- 3.157 kl/1,000 ton — Engine oil (70%)
- 1.353 kl/1,000 ton — Marine cylinder oil (30%) (Industrial oil)

(3) Lube Oil Consumption in 1983 and 1993

	Fish Captured (1,000 ton)	Engine Oil (kl)	Marine Cylinder Oil (Industrial Oil) (kl)	Total
1983	1,959	6,185	2,650	8,835
1993	1,760	5,557	2,381	7,938

3-3 Forest

(1) Wood Production and Lube Oil Consumption

(Unit: m^3)

	1982	1983
Teak	58,076	56,843
Others	1,711,282	1,517,856
Total	1,769,358	1,574,699

Lube oil consumption: engine oil 141 lit/year in 1982.

Source: Ministry of Agriculature and Cooperatives, Thailand.

(2) Lube Oil Consumption in 1983 and 1993

	(1982)	1983	1993
Forest Production(m^3)	(1,769,358)	1,574,699	1,574,699
Engine Oil Consumption(kl)	(0.141)	0.125	0.125

The wood production decreased from 1,769,358m^3 of 1982 to 1,574,699m^3 of 1983, thus the Consultant estimates that average annual growth rate is zero from 1983 to 1993.

3-4 Cold Storage

		Company A	1983	1993
Cold Storage Capacity	(ton)	3,500 1)		
	(m^3)	3,000 1)	7,814 2)	9,556 3)
Lube Oil Consumption (kl) (Industrial Oil)		24 1)	63	76

Note: 1) Answer of Company A

2) Cold storage capacity in Thailand is estimated by Ministry of Agriculture and Cooperatives.

	1982	1983	1985	1990	1995
Capacity (m^3)	7,546	7,814	8,205	9,025	9,228

3) Cold storage capacity in 1993 is estimated from above figure.

CONCLUSION OF "3" AGRICULTURE, FISHERY, FOREST AND COLD STORAGE

LUBRICATING OIL CONSUMPTION (1)
AGRICULTURE, FISHERY, FOREST AND COLD STORAGE

	Answer for Questionnaire					1983					Average Growth Rate (1983-1993)
	Production (1983)	Lubricating Oil Consumption (kl)				Production	Lubricating Oil Consumption (kl)				
		Engine Oil	Industrial Oil	Grease	Total		Engine Oil	Industrial Oil	Grease	Total	
3-1 Agriculture		N.A.				-	6,688.0	3,947.0	-	10,635.0	Final Rate 5
3-2 Fishery	1,959,000 ton	-	-	-	-	1,959,000 ton	6,688.0	2,650.0	-	8,835.0	
3-3 Forest	1,769,000 m^3 *)	141 lit./y	-	-	-	1,575,000 m^3	0.125	-	-	0.125	0
3-4 Cold Storage	3,000,000 m^3	-	8 lit./y		-	7,814,000 m^3	-	63.0	-	63.0	
Total							12,873.1	6,660.0	-	19,533.1	

Note: *) 1982

CONCLOSION OF "3" AGEICULTURE, FISHERY, FOREST AND COLD STORAGE

LUBRICATING OIL CONSUMPTION (2)
AGRICULTURE, FISHERY, FOREST AND COLD STORAGE

		1 9 9 3				
			Lubricating Oil Consumption (kl)			
		Production	Engine Oil	Industrial Oil	Grease	Total
3-1	Agriculture	-	14,890	9,414	-	24,304
3-2	Fishery	1,760,000 ton	5,557	2,381	-	7,938
3-3	Forest	1,575,000 m^3	0.125	-	-	0.125
3-4	Cold Storage	9,556,000 m^3	-	76	-	76
	Total		20,447.1	11,871.0	-	32,318.1

4 Construction

Construction Cost and Lube Oil Consumption

	Unit Lube[3] Oil Consumption (lit./ million Bahts)	1978	1981	1983	1993
Consumption Expence (million Bahts)		13,583[1]	16,660[1]	19,074[2]	37,522[2]
Total Lube Oil Consumption	0.08457			1,613	3,173
Breakdown					
Engine Oil	0.02114			403	793
Industrial Oil	0.06343			1,210	2,380

Notes: 1) Source: NESDB

2) Growth rate is estimated as 7% which is the same growth rate between 1978 and 1981.

3) Unit lube oil consumption is estimated from the experience in Japan.

CONCLUSION OF "4" CONSTRUCTION

LUBRICATING OIL CONSUMPTION (1)
CONSTRUCTION

	Answer for Questionnaire					1 9 8 3					Average Growth Rate (1983-1993)
	Production	Lubricating Oil Consumption (kl)				Production	Lubricating Oil Consumption (kl)				
		Engine Oil	Industrial Oil	Grease	Total		Engine Oil	Industrial Oil	Grease	Total	
4 Construction		N.A.				19,704 million b *)	403.0	1,210.0	-	1,613.0	7

Note: *) bahts

CONCLUSION OF "4" CONSTRUCTION

LUBRICATING OIL CONSUMPTION (2)
CONSTRUCTION

		1 9 9 3				
			Lubricating Oil Consumption (kl)			
		Production	Engine Oil	Industrial Oil	Grease	Total
4	Construction	37,522,000 bahts	793.0	2,380.0	-	3,173.0

5 Electric Power Generation

5-1 Electric Power Generation of Electricity Generation Authority of Thailand (EGAT)

(1) Forecast of Electric Power Generation of EGAT

ELECTRIC POWER GENERATOR
(INSTALLED CAPACITY & FUTURE CAPAXITY)

(Unit: MW)

	Hydro Power	Thermal	Gas Turbine	Gas Turbine Combined Cycle	Diesel	Toal
EGAT April 1982	1,380	1,927.5	745		34.6	4,087.1
	1,380.6	1,927.5	745		33.6	4,086.7
EGAT 1983	1,496.9	2,477.5	265	720	33.6	4,993.0
EGAT 1985	1,988.9	3,477.5	265	720	33.6	6,485.0
EGAT 1990	2,502.7	4,302.5	265	720	33.6	7,823.8
EGAT 1995	3,522.7	5,805.0	130	720	33.6	10,211.3

Source: EGAT

(2) Lube Oil Consumption in 1983 and 1993

	1983	1993
Power Generator Capacity (MW)	4,954.9[3]+33.6[2]	9,145.5[3]+33.6[2]
	Total 4,993	9,179.1
Engine Oil (kl)	5 (4,854 lit[1])	5[4]
Industrial Oil (kl)	298 (297,710 lit[1])	550[4]
Total (kl)	303 (302,564 lit[1])	555[4]

Notes: 1),2),3) Source: EGAT

2) Power generation capacity (MW) of diesel is no change from 1982 to 1995.

3) Other power generation capacity (MW) except diesel is hydro, thermal, gas turbine, gas turbined combined cycle. These are increasing every year.

4) Calculated from the expected capacity of electric power generation.

5-2 Electric Power Generation of Provincial Electricity Authority (PEA)

(1) Forecast of Electricity Power Generation of PEA

ELECTRIC POWER GENERATOR
(INSTALLED CAPACITY & FUTURE CAPACITY)

(Unit: MW)

	Hydro Power	Thermal	Gas Turbine	Combined Cycle	Diesel	Total
April	-	-	-	-	29.5	29.5
PEA 1982	-	-	-	-	20.083	20.083
PEA 1983	-	-	-	-	20.083	20.083
PEA 1985	-	-	-	-	20.083	20.083
PEA 1990	-	-	-	-	20.083	20.083
PEA 1995	-	-	-	-	20.083	20.083

Source: PEA

(2) Lube Oil Consumption in 1983 and 1993

	Diesel Engine Oil (kl)
1983	252[1)]
1993	252

Note: The growth rate of electricity power generation is zero percent.

1) Source: PEA

CONCLUSION OF "5" ELECTRIC POWER GENERATION

LUBRICATING OIL CONSUMPTION (2)
ELECTRIC POWER GENERATION

	Answer for Questionnaire					1 9 8 3					Average Growth Rate (1983-1993)
	Production	Lubricating Oil Consumption (kl)				Production	Lubricating Oil Consumption (kl)				
		Engine Oil	Industrial Oil	Grease	Total		Engine Oil	Industrial Oil	Grease	Total	
5-1 EGAT	4,993 MW	4,854 lit.	297,710 lit.	-	302,564 lit.	4,993 MW	5.0	298.0	-	303.0	
5-2 PEA	20,083 MW	251,656 lit.	-	-	251,656 lit.	20,083 MW	252.0	-	-	252.0	0
Total							257.0	298.0	-	555.0	

CONCLUSION OF "5" ELECTRIC POWER GENERATION

LUBRICATING OIL CONSUMPTION (2)
ELECTRIC POWER GENERATION

	1993				
	Production	Lubricating Oil Consumption (kl)			
		Engine Oil	Industrial Oil	Grease	Total
5-1 EGAT	9,179 MW	5.0	550.0	-	555.0
5-2 PEA	20,083 MW	252.0	-	-	252.0
Total		257.0	550.0	-	807.0

6 Manufacturing

6-1 Refinery

(1) Lube Oil Consumption Ratio of 3 Refineries

Production[1] Total in 1982 (1,000 kl)	Total Production Ratio (as AR[6]=1.00)	Light Production in 1982 (1,000 kl)	Light Production Ratio (as AR[6] 1.00)	Lube Oil Consumption Ratio (as AR[6]=1.00)
Refinery A 2,726	1.00	1,532	1.00	1.00
Refinery B 3,363	1.23[2]	2,745	2.79[3]	1.63[4]
Refinery C 2,704	0.99	1,847	1.21	0.873[5]

Notes: 1) Source: OIL AND THAILAND 1982

4) The lube oil consumption ratio of Refinery B (as Refinery A=1.00) is calculate as follow.
$\{ (2) + 3)) - 2 \}^{0.7}$

5) The lube oil consumption ratio of Refinery C (as Refinery A=1.0) is estimated from CRUDE TOPPING CAPACITY (Source: EMP).

6) AR is Refinery A.

(2) Lube Oil Consumption in 3 refineries in 1983 and 1993

	Refinery A*1 Lube Oil Consumption (kl)		Refinery B*1 Lube Oil Consumption (kl)		Refinery C*1 Lube Oil Consumption (kl)		Total (kl)	
	1983[1]	1993	1983[2]	1993	1983[2]	1993	1983	1993
Engine Oil	1.8	2.1	2.9	5.4	1.6	2.1	6.3	9.6
Industrial Oil	30.3	35.8	49.4	91.2	26.5	34.7	106.2	161.7
Total	32.1	37.9	52.3	96.6	28.1	36.8	112.5	171.3

Notes: 1) Answer of Refinery A

2) 1) x Lube oil consumption ratio (as Refinery A 1.00)

*1 Lube oil consumption of each year for 3 refineries is corresponded to CRUDE OIL TOPPING CAPACITY (source: EMP).

		1983	1993	Capacity Increase Ratio Between 1983/1993
Topping Capacity (1,000 bbl)	Ref.A	20,075	23,725	1.1818
	Ref.B	23,725	43,800	1.8462
	Ref.C	17,520	22,995	1.3125
		61,320	90,520	1.4762

The lube oil consumption for increase topping capacity of every year is a half.

6-2 Viscose Rayon

(1) Viscose Rayon Production in 1983, Answer of Company A: 17,000 ton

The future average annual growth rate of viscose rayon production in Thailand is estimated zero.

(2) Lube Oil Consumption in 1983 and 1993

	1983 (kl)	1993 (kl)
Industrial Oil	8	8
Grease	1.2	1.2
Total	9.2	9.2

Note: The lube oil consumption in 1983 is the answer of Company A.

6-3 Nylon and Polyester

(1) Nominal (Name Plate) Capacity and Production in Thailand

	Polyester Staple	Polyester Filament	Nylon Filament	Nylon Staple	Total
Nominal Capacity in 1982 (ton/day)					
Teijin	120	30	-	-	150
Thai Melon	60	20	-	-	80
Toray Nylon Thai	-	20	15	-	35
Asia Fiber	-	-	15	-	15
Hantex	-	7	12	-	19
Oriental Fiber	-	-	-	45	45
Total	180	77	42	45	344
Production in 1982 (ton/year)					(113,520[1])
	48,958	19,726	13,634		82,318

Note: 1) 344 ton/day x 330 days = 113,520 ton/year (Nominal Capacity)

Source: Japan Chemical Fiber Association

Average annual growth rate is 8.9% which is estimated from EMP data of the raw textile growth rate between 1982 (1,385 MMSY) and 2001 (6,992 MMSY).

(2) Production and Lube Oil Consumption, Answer of Company A

Production in 1983	
Nylon Filament Yarn	6,866 ton/year
Polyester Filament Yarn	7,682 ton/year
Total	14,548 ton/year

Lube oil consumption in 1983

Industrial Oil	23,374 lit[1] / 14,548 ton/year	= 1.61 lit/ton
Grease	234 lit[1] / 14,548 ton/year	= 0.016 lit/ton
Total	23,608 lit	

Source: 1) Answer of Company A

(3) Production and Lubricating Oil Consumption in Thailand in 1983 and 1993

	Nylon and Polyester Production[1] (ton)	Industrial Oil[2] (kl)	Grease[2] (kl)	Total (kl)
1983	89,644	139	1.4	140.4
1993	210,282	257	2.6	259.6

Notes: 1) The consultant estimates production in 1983 and 1993 based on the data of Japanese Chemical and Fibre Association 82,318 ton in 1982, and growth rate 8.9% which is raw textile growth rate estimated by EMP.

2) Answer of Company A

1. The lube oil consumption for increased production of each year is a half.

2. The consultant assumes when production is increased 1.5 times (50% up) of 1983 production, a new plant is installed. The year of newly installation the lube oil consumption is 100%.

6-4 Textile Fabric

(1) Textile Machineries in Thailand

Number of textile machineries is shown in Table AII-1-9.

Average annual growth rate of spinning is 10.2% from 1971 to 1981, and that of weaving is 5.3%, but the Consultant estimates those growth rates of 8.9% as is estimated by EMP.

(2) Unit Lube Oil Consumption

Unit lube oil consumption of spinning and waring are show in Table AII-1-10.

(3) Number of Machines and Lube Oil Consumption in Thailand in 1983 and 1993

	Number of Machineries Units[1]	Engine Oil (kl)[2]	Industrial Oil (kl)[2]	Grease (kl)[2]	Total (kl)
in 1983					
Spinning	1,572,748	-	60	12	72
Weaving	57,338	8	177	1.7	186.7
Total		8	237	13.7	258.7
in 1993					
Spinning	1,712,726	-	140	28	168
Weaving	62,441	19	415	4	438
Total		19	555	32	606

Notes: 1) Estimated from Table AII-1-9.

2) Estimated from Table AII-1-10.
The lube oil consumption for increase number of machineries for each year is 100%, not a half, because the textile industry is gathering small machines.

6-5 Fertilizer (Excepting New Fertilizer Plant Based on Natural Gas)

(1) Production and Lube Oil Consumption in 1983, Answer of Company A

Production: 252,050 ton

Lubricating Oil Consumption and Unit Consumption

Engine Oil	3,947 lit./252,050 ton	= 0.0157 kl/1,000 ton
Industrial Oil	24,112 lit./252,050 ton	= 0.0957 kl/1,000 ton
Grease	2,084 lit./252,000 ton	= 0.0083 kl/1,000 ton
	30,143 lit.	

(2) Thai Production

Production in 1983: 290,000 ton
(Source: Company B)

Average annual growth rate is the same with Thai GDP growth rate.

(3) Production and Lubricating Oil Consumption in Thailand in 1983 and 1993

	Compound Fertilizer (1,000 ton)	Engine Oil (kl)	Industrial Oil (kl)	Grease (kl)	Total (kl)
1983	290	5	28	2.4	35.4
1993	368	5	32	2.8	39.8

Notes: (1) The lube oil consumption for increased production of each year is a half.

(2) New fertilizer project will be completed in October 1986, thus the production of existing plant will not be increased after 1987.

6-6 Sugar

(1) Process Sugar Production and Lube Oil Consumption in 1983, Answer of Company A.

Production	
White Sugar	34,042.45 ton
Refined Sugar	39,852.80 ton
Raw Sugar	73,864.03 ton
Total	147,759.28 ton

Lube Oil consumption and unit consumption

Engine Oil	6,279.5 lit./147,759.28 ton	= 0.042 kl/1,000 ton
Industrial Oil	53,922.0 lit./147,759.28 ton	= 0.365 kl/1,000 ton
Grease	1,745.5 lit./147,759.28 ton	= 0.012 kl/1,000 ton
Total	61,947.0 lit.	

(2) Sugar Production and Lube Oil Consumption in Thailand Between 1983 and 1993

PROCESS SUGAR PRODUCTION AND LUBE OIL CONSUMPTION

	Process Sugar Production (1,000 ton)	Engine Oil (kl)	Industrial Oil (kl)	Grease (kl)	Total (kl)
1982	2,768[1]	116.3	1,010.3	33.2	1,159.8
83	2,666	114.2	991.7	32.6	1,138.5
84	2,568	112.1	973.8	32.0	1,117.9
85	2,473	110.1	956.5	31.4	1,098.1
86	2,382[1]	108.2	939.9	30.9	1,079.0
87	2,525	111.2	966.0	31.8	1,109.0
88	2,676	114.4	993.6	32.7	1,140.7
89	2,837	117.8	1,023.0	33.7	1,174.5
1990	3,007	121.4	1,054.0	34.7	1,210.1
91	3,187[1]	125.2	1,086.9	35.8	1,247.9
92	3,378	129.2	1,121.8	36.9	1,287.9
93	3,581	133.5	1,158.8	38.1	1,330.4

Note: 1) Source: EMP

Production other than the above is estimated by the Consultant based on EMP data.

The lube oil consumption for increased or decreased production of every year is a half.

6-7 Rubber

(1) Tires and Inner Tubes Production and Lube Oil Consumption in 1983, Answer of Company A

Production

	Tires	Tubes
Vehicle (Standard Type)	61,784	43,973
Vehicle (Radial Type)	181,250	
Pick up	292,241	167,321
Bus & Truck	139,079	121,265
Tractor (Front Wheel)	11,597	12,402
Tractor (Rear Wheel)	14,145	12,068
Grades	12,011	13,142
Total	712,107	370,171
Total	1,082,278	

Lube Oil Consumption and Unit Consumption

		Unit Lube Oil Consumption
Engine Oil	627 lit.	0.58 lit./1,000 tires and tubes
Industrial Oil	16,326 lit.	15.08 lit./1,000 tires and tubes
Grease	3,420 lit.	
	20,373 lit.	

(2) Production of Tires and Tubes and Average Annual Growth Rate in Thailand

TYRES AND TUBES PRODUCTION, 1976-1980

(Units)

	Passenger Car Tyres	Truck and Bus Tyres	Tractor Tyres	Tubes & inner rubber	Total tyres	Total
1976	463,922	826,050	42,289	1,332,261	803,780	2,136,041
1977	573,065	1,101,416	60,868	1,735,349	1,004,727	2,740,076
1978	708,680	1,285,822	64,498	2,059,000	1,118,864	3,177,864
1979	575,766	1,219,551	49,379	1,844,696	1,213,285	3,057,981
1980	517,007	1,151,409	49,414	1,718,830	1,345,420	3,064,250
1983						3,650,000
1988						6,536,000

Average annual growth rate based on Bank of Thailand data between 1976 and 1980 is 9.4% in total. But the Consultant estimates growth rate of tires and tubes as 6% of the growth rate of vehicles.

(3) Production of Tires and Tubes and Lube Oil Consumption in Thailand in 1983 and 1993

PRODUCTION OF TIRES AND TUBES

	Production of Tires and Tubes (1,000 units)	Engine Oil (kl)	Industrial Oil (kl)	Grease (kl)	Total (kl)
1983	3,650	2.1	51	10.6	63.7
1993	6,536	3.2	76	14.2	93.4

6-8 Plywood

(1) Production of Plywood and Lube Oil Consumption, Answer of Ministry of Agriculture and Cooperatives of Thailand

Kind of Plywood	1982	1983	1985	1990	1995
Plywood (sheet)	2,014,323	2,497,232	2,800,000	3,600,000	4,000,000
Hard board (sheet)	3,241,157	4,088,500	4,500,000	5,500,000	7,000,000
Total	5,255,480	6,585,732	7,300,000	9,100,000	11,000,000
Lube Oil(lit.)	43,724	51,945	54,500	59,950	64,900
Grease (lit.)	2,012	2,160	2,200	2,300	2,390
Total	45,736	54,105	56,700	62,250	67,290

(2) Production of Plywood and Lube Oil Consumption in Thailand Between 1983 and 1993

	Production (1,000 sheets)	Industrial Oil (kl)	Grease (kl)	Total (kl)
1983	6,586[1)]	51.9[1)]	2.2[1)]	54.1[1)]
1984	6,943	53.2	2.2	55.4
1985	7,300[1)]	54.5[1)]	2.2[1)]	56.7[2)]
1986	7,629	55.6	2.2	57.8
1987	7,973	56.6	2.2	58.9
1988	8,332	57.7	2.3	60.0
1989	8,708	58.9	2.3	61.2
1990	9,100[1)]	60.0[1)]	2.3[1)]	62.3[1)]
1991	9,452	60.0	2.3	63.2
1992	9,817	61.9	2.3	64.2
1993	10,197	62.9	2.4	65.3

Note: 1) Data of production and lube oil consumption is mentioned in above figure.

Source: Ministry of Agriculature and Cooperatives of Thailand

6-9 Cement

(1) Production of Cement and Lube Oil Consumption in 1983, Answer of Company A

Production:

Mixed Cement	3,264,000 ton
Portland Cement (X)	1,359,000 ton
Portland Cement (Y)	124,000 ton
Total	4,747,000 ton

Lube oil consumption and unit consumption:

Engine Oil	85,422 lit./4,747,000 ton	= 0.0180 kl/1,000 ton
Industrial Oil	168,138 lit./4,747,000 ton	= 0.0354 kl/1,000 ton
Grease	3,767 lit./4,747,000 ton	= 0.00079 kl/1,000 ton
Total	257,327 lit.	

(2) Cement Production in Thailand Between 1982 and 2001

	1982	1986	1991	1996	2001
Cement (million ton)	6.66	8.53	11.52	15.57	21.03

(Source: EMP)

(3) Production of Cement and Lube Oil Consumption in Thailand Between 1983 and 1993

PRODUCTION AND LUBE OIL CONSUMPTION

	Production[1] (million ton)	Engine Oil (kl)	Industrial Oil (kl)	Grease (kl)	Total (kl)
1983	7.09	124	244	6	374
1993	13.00	183	360	8	551

Note: 1) The production in each year is estimated based on EMP data.

1. The lubricating oil consumption for increased production in each year is a half.

2. The year of newly installation, the lube oil consumption is 100%.

6-10 Plate Glass

(1) Production of Plate Glass and Lube Oil Consumption, Answer of Company A

Production in 1983:

Sheet Glass: 5,000 cases/day

4 kg/case x 5,000 cases = 225,000 kg/day

= 74,250 ton/year

(Operation days: 330)

(2) Lube Oil Consumption in 1983

	lit	Unit kl/1,000 ton
Engine Oil	1,764	0.0238
Industrial Oil	3,873	0.0522
Grease	2,006	0.0270
Total	7,643	

(3) Plate Glass production in Thailand

	1982	1986	1991	1996	2001
Plate Glass (1,000 ton)	85	102	139	188	255

(Source: EMP)

(4) Production of Plate Glass and Lube Oil Consumption in Thailand in 1983 and 1993

	Plate glass Production[1] (1,000 ton)	Engine[2] Oil (kl)	Industrial[2] Oil (kl)	Grease[2] (kl)	Total (kl)
1983	69	2.1	4.6	2.4	9.1
1993	157	3.7	8.2	4.2	16.1

Notes: 1) The production of each year is estimated based on EMP data.

2) The lube oil consumption for increased production is not a half, because the lube oil consumption is very small.

6-11 Caustic Soda

(1) Production of Caustic Soda and Lube Oil Consumption in 1983, Answer of A Company

Production in 1983:

NaOH	60,739 ton

Caustic Soda Production in Thailand is same as Company A.

(2) Lube Oil consumption

Engine Oil	14,400 liter

(3) Forecast of Caustic Soda Production

New petrochemical project is completed in July 1987, thus the caustic soda production by existing plant will not be increased after 1988.

(4) Average Annual Growth Rate

	1970	1980	
NaOH Production in Thailand	32,745	62,130	Growth Rate 6.68 p.a. (1970-1980)

Source: Bangkok and Japan Treading Center.

(5) Lube Oil Consumption in 1983 and 1984

	NaOH Production (ton)	Industrial Oil (kl)
1983	60,739	14.4
1993	78,433	18.6

Note: The lube oil consumption is not a half for increasing product, because the lube oil consumption is very small.

6-12 Gas (O_2, N_2)

(1) Production of Oxygen and Nitrogen Gas and Lube Oil Consumption in 1983, Answer of A Company

Production

Liquid Oxygen	6,704,000 SM^3
Nitrogen	3,270,000 SM^3
Total	9,974,000 SM^3

Lube Oil Consumption

Engine Oil	50 lit.
Industrial Oil	12,400 lit.
Total	12,450 lit.

(2) Gas (O_2, N_2) Production in Thailand

There are 6 similar kind of companies (source: Siam Directory), therefore the consultant estimates that Thai production is 5 times of Company A's production to be considered plant size.

Production in 1983

$$9,974,000\ SM^3 \times 5 = 49,870 \times 10^3\ SM^3$$

Lube Oil Consumption in 1983

Engine Oil 50 lit. x 5 = 250 lit. = 0.3 kl
Industrial Oil 1,243 lit. x 5 = 6,215 lit. = 6.2 kl

(3) Average Annual Growth Rate

Average annual growth rate is estimated as follows which is the same of estimated growth rate of GDP.

(4) Production and Lube Oil Consumption in 1983 and 1993

	Production of Gases (1,000 SM^3)	Engine Oil (kl)	Industrial Oil (kl)	Total (kl)
1983	49,870	0.3	62	62.3
1993	92,301	0.4	92	92.4

Note: The lube oil consumption for increasing production in each year is a half. The year of newly installation the lube oil consumption is 100%.

6-13 Steel and Iron (Electric Furnace Products)

(1) Production and Lube Oil Consumption in 1983, Answer of Company A

Production: 147,934.98 ton

Lube oil consumption and Unit Consumption

Engine Oil	19,049.00 lit./147,934.98 ton	= 0.1288 kl/1,000 ton
Industrial Oil	15,753.65 lit./147,934.98 ton	= 0.1065 kl/1,000 ton
Grease	55,728 lit./147,934.38 ton	= 0.3767 kl/1,000 ton
Total	90,530.65	

(2) Thai Electric Furnace Production

Name of Company	Annual Production Capacity	Production Past Record 1977	1978	1979
The Bangkok Iron Steel Works Co., Ltd.	120,000 MT	47,400	48,700	39,200
Bangkok Steel Industries Ltd.	90,000 MT	44,000	70,000	70,000
G.S. Steel Co., Ltd.	140,000 MT	95,000	100,000	117,000
The Siam Iron & Steel Co., Ltd.	135,000 MT	96,200	127,500	127,000
Thai India Steel Co., Ltd.	42,000 MT	N.A.	16,000	21,000
Thai Pattana Casting Steel Co., Ltd.		N.A.	N.A.	8,000
Total	527,000	282,600	362,200	382,200

Average annual growth rate was 16% between 1977 and 1979.

The consultant estimates the growth rate in 1979 as 16%, then the growth rate has been going down 1% every year, and after 1988 the growth rate will be constant of as 7%.

(3) Lube Oil Consumption in 1983 and 1993

	Electric Furnace Products Production (1,000 ton)	Engine Oil (kl)	Industrial Oil (kl)	Grease (kl)	Total (kl)
1983	634	65	53	192	310
1993	1,367	122	100	371	593

Note: Lube Oil Consumption is a half for increased production. The year of newly installation the lube oil consumption is 100%.

6-14 Parts

(1) Production and Lube Oil Consumption in 1983, Answer of Company A and Company B

1. Answer of A company

Products: Vehicle part
Lube Oil Consumption: Engine Oil 4.5 kl

There are 12 similar companies (Source: Siam Directory).

2. Answer of Company B

Products: Pipes and Fittings 2,600 ton
Lube Oil Consumption: Engine Oil 0.3 kl
Industrial Oil 13.5 kl

There are 16 similar companies
(Source: Siam Directory).

3. Total of Lube Oil Consumption

	Engine Oil	Industrial Oil
Vehicle Parts	4.5x12 = 54kl	-
Pipes and Fittings	0.3x16 = 5kl	13.5x16 = 216kl

(2) Average Annual Growth Rate

Average annual growth rate is estimated as the same of estimated growth rate of GDP.

(3) Lube Oil Consumption in 1983 and 1993

	Engine Oil (kl)	Industrial Oil (kl)	Total (kl)
1983	59	216	275
1993	109	399	508

Note: Parts shops are very small, so the consultant estimates lube oil consumption for increased production is not a half.

6-15 Plastic Polymer

(1) Production and Lube Oil Consumption in 1983, Answer of Company A

Production:

PVC Resin	43,171 ton
PVC Compound	20,044 ton
Total	63,215 ton

Lube oil consumption:

Industrial Oil	9,053 liter

(2) Plastic Polymers Production in Thailand

	1980[1]	1983[2]	1993[2]
PVC Resin (ton)	48,000		
PVC Compound (ton)	24,000		
Total (ton)	62,000	73,843	136,670

Notes: 1) Source: Industrial Finance Corporation Thailand (IFCT)

2) The Consultant estimates the production by the growth rate of production is same to Thai GDP growth rates.

3. Lubricating Oil Consumption in 1983 and 1993

	Plastic Polymer Production (ton)	Industrial Oil (kl)
1983	73,843	10.6
1993	136,670	19.6

Note: Lube Oil consumption for increased production is not a half, because lube oil consumption is very small.

6-16 Paper

(1) Production and Lube Oil Consumption in 1983, Answer of Companies A, B, and C

	Paper Production (ton)	Engine Oil (lit.)	Industrial Oil (lit.)	Grease (lit.)	Total (lit.)
Company A (Refined paper)	12,109.69	3,277	57,653	1,171	62,101
Company B (Tissue paper)	9,000	697	5,686	220	6,603
Company C (Board)	49,500		43,100		43,100
Total	70,609.69	3,974	106,439	1,391	111,804

(2) Paper Production in Thailand

	1982	1986	1991	1996	2001
Paper (1,000 ton)	362	748	1,102	1,624	2,392

(Source: EMP)

(3) Lube Oil Consumption in 1983 and 1993

	Paper Production (1,000 ton)	Engine Oil (kl)	Industrial Oil (kl)	Grease (kl)	Total (kl)
1983	434	22	600	8	630
1993	1,287	55	1,447	20	1,522

Note: Lube Oil Consumption is a half for increased production of every year, the year of newly installation the lube oil consumption is 100%.

6-17 Liquid CO_2 and Dry Ice

(1) Production and Lube Oil Consumption in 1983, Answer of Company A

PRODUCTION AND LUBE OIL CONSUMPTION

	Production	Lube Oil Consumption (Industrial Oil)
Liquid CO_2	2,900 ton	
Dry Ice	225 ton	
Total	3,125 ton	2.2 kl

(2) Liquid CO_2 and Dry Ice Production in Thailand

There are two companies producing liquid CO_2 and dry ice (Source: Siam Directory).

The Consultant estimates that Thai Production is 3 times of Company A's production due to the capacity.

3,125 ton x 3 = 9,375 ton in 1982

(3) Average Annual Growth Rate

The consultant estimates the growth rates which is the same of estimated Thai GDP growth rate.

(4) Lubricating Oil Consumption in 1983 and 1993

	Liquid CO_2 & Dry Ice Production (1,000 ton)	Industrial Oil (kl)
1983	10.0	7.0
1993	18.5	13.0

Notes: (1) Lube oil consumption for increased production is not a half because lube oil consumption is very small.

(2) Liquid CO_2 and dry ice production capacity is big, so it is not necessary to install new plant within 1993.

6-18 Beverage

(1) Production and Lube Oil Consumption in 1983, Answer of Company A

Production:

Beer and Soft Drink 180,802 kl

Lube oil consumption

	lit.	Unit consumption (kl/1,000 kl)
Engine Oil	10,023	0.0554
Industrial Oil	5,016	0.0277
Total	15,039	

(2) Beverage Production in Thailand

	1982	1986	1991	1996	2001
Beverage (10^6 ton)	1.05	1.40	2.04	1.96	4.31

(Source: EMP)

The Consultant assumed 1 ton ~~is~~ of beverage is same as 1kl.

(3) Lube Oil Consumption

	Beverage Production (1,000 kl)	Engine Oil (kl)	Industrial Oil (kl)	Grease (kl)	Total (kl)
1983	1,128	60.4	30.2	0.8	91.4
1993	2,368	102.7	51.3	1.4	155.4

Notes: Lube oil consumption for increased production of each year is a half. And the year of newly installation of plant is 100%.

CONCLUSION "6" MANUFACTURING

LUBRICATING OIL CONSUMPTION (1)
MANUFACTURING (1)

		Answer for Questionnaire					1983					Average Growth Rate (1983-1993)
		Production	Lubricating Oil Consumption (kl)				Production	Lubricating Oil Consumption (kl)				
			Engine Oil	Industrial Oil	Grease (ton)	Total		Engine Oil	Industrial Oil	Grease (ton)	Total	
6-1	Refinery	Topping Cap. of A Ref.*) 2,726,000kl	1.8	30.3	-	32.1	Topping Capacity 61,320,000kl	6.3	106.2	-	112.5	NEA Data
6-2	Viscose Rayon	17,000 ton	-	8.0	1.2	9.2	17,000 ton	-	8.0	1.2	9.2	0
6-3	Nylon Acid Polyester	14,548 ton	-	23.374	0.234	23.608	89,644 ton	-	139.0	1.4	140.4	8.9
6-4	Textile Fabric		N.A.					8.0	237.0	13.7	258.7	6.9
6-5	Fertilizer	252,050 ton	3.947	24.112	2.084	30.143	290,000 ton	5.0	28.0	2.4	35.4	GDP Growth Rate
6-6	Suger	147,759 ton	6.2785	53.922	1.7455	61.947	2,666,000 ton	114.2	991.7	32.6	1,138.5	EMP Data
6-7	Rubber	1,082,000 Tires & Tubes	0.627	16.326	3.42	20.373	3,650,000 tires & Tubes	2.1	51.0	10.6	63.7	6
6-8	Plywood	6,586,000 Sheets	-	51.945	2.16	54.105	6,586,000 Sheets	-	51.9	2.2	54.1	Government Data
6-9	Cement	4,747,000 ton	85.422	168.138	3.767	257.327	7,090,000 ton	124.0	244.0	6.0	374.0	EMP Data
6-10	Plate Class	74,250 ton	1.764	3.873	2.006	7.643	89,000 ton	2.1	4.6	2.4	9.1	EMP Data
6-11	Caustic Soda	60,739 ton	14.400	-	-	14.4	60,739 ton	14.4	-	-	14.4	-6.6

Note: *) 1982

LUBRICATING OIL CONSUMPTION (1)
MANUFACTURING (2)

		Answer for Questionnaire					1983					Average Growth Rate (1983-1993)
		Production	Lubricating Oil Consumption (kl) Engine Oil	Industrial Oil	Grease (Ton)	Total	Production	Lubricating Oil Consumption (kl) Engine Oil	Industrial Oil	Grease (Ton)	Total	
6-12	Gas (O_2, N_2)	9,974,000 sm^3	0.05	12.4	-	12.45	49,870 sm^3	0.3	62.0	-	62.3	GDP Growth Rate
6-13	Steel and Iron	147,935,000 ton	19.049	15.754	55.728	90.531	634,000 ton	65.0	53.0	192.0	310.0	16% - 7%
6-14	Parts	Answer of 2 Companies	4.8	13.5	-	18.3	-	59.0	216.0	-	275.0	GDP Growth Rate
6-15	Plaste Polymer	63,215 ton	-	9.053	-	9.053	73,843 ton	-	10.6	-	10.6	GDP Growth Rate
6-16	Paper	70,610,000 ton	3.974	106.44	1.39	111.804	434,000 ton	22.0	600.0	8.0	630.0	EMP Data
6-17	Liquid CO_2 of Dry Ice	3,125 ton	-	2.2	-	2.2	10,000 ton	-	7.0	-	7.0	GDP Growth Rate
6-18	Veverage	180,802 kl	10.023	5.016	-	15.039	1,128,000 kl	60.4	30.2	0.8	91.4	EMP Data
	Total							482.8	2,840.2	273.3	3,596.3	
	Plus 10%							531.1	3,124.2	300.6	3,955.9	

CONCLUSION "6" MANUFACTURING

LUBRICATING OIL CONSUMPTION (2)
MANUFACTURING (1)

		1993				
		Production	Lubricating Oil Consumption (kl)			Remarks
			Engine Oil	Industrial Oil	Grease	Total
6-1	Refinery	90,520,000 bahts	9.6	161.7	-	171.3
6-2	Viscope Rayon	17,000 ton	-	8.0	1.2	9.2
6-3	Nylon and Polyester	210,282 ton	-	257.0	2.6	259.6
6-4	Textile Fabric		19.0	555.0	32.0	606.0
6-5	Fertilizer	369,000 ton	5.0	32.0	2.8	39.8
6-6	Sugar	3,581,000 ton	133.5	1,158.0	38.1	1,330.4
6-7	Rubber	6,536,000 Tires & Tubes	3.2	76.0	14.2	93.4
6-8	Plywood	10,197,000 Sheet	-	62.9	2.4	65.3
6-9	Cement	13,000,000 ton	183.0	360.0	8.0	551.0
6-10	Plate Glass	157,000 ton	3.7	8.2	4.2	16.1
6-11	Caustic Soda	78,433 ton	18.6	-	-	18.6

LUBRICATING OIL CONSUMPTION (2)
MANUFACTURING (2)

		1 9 9 3					
			Lubricating Oil Consumption (kl)				
		Production	Engine Oil	Industrial Oil	Grease	Total	Remarks
6-12	Gas (O_2, $N_2$4, ' others)	92,301,000 sm^3	0.4	92.0	-	92.4	
6-13	Steel and Iron	1,367,000 ton	122.0	100.0	371.0	593.0	Electric furnace products
6-14	Parts		109.0	399.0	-	508.0	Parts of vehicle, pipes and fittings
6-15	Plastic Polymer	136,670 ton	-	19.6	-	19.6	
6-16	Paper	1,287,000 ton	55.0	1,447.0	20.0	1,522.0	
6-17	Dry Ice	18,500 ton	-	13.0	-	13.0	
6-18	Veverage	2,368,000 ton	102.7	51.3	1.4	155.4	
	Total		764.7	4,801.5	497.9	6,064.1	
	Plus 10%		841.2	5,281.7	547.7	6,670.6	

7 New Project

7-1 Gas Separation Plant

(1) Treated Gas 350 SCFD

(2) Completion Date Nov. 14, 1984

(3) Production

Production for Gas Separation Project

C_2	358,000 ton/year
C_3	223,000 ton/year
LPG (C_3, C_4)	250,000 ton/year (C_3 35%)
NGL	83,000 ton/year

(4) Lube Oil Consumption for Gas Separation

Lubricating oil consumption for gas Separation project:

(Unit: kl)

	1984	1985
Engine Oil	12	82.0
Industrial Oil	32	58.46
Grease	0.037	0.13
Total	44.037	140.59

(Source: Constructor)

Note: Lube oil consumption in 1993 is same as in 1985.

7-2 Fertilizer Project

A fertilizer project in Thailand now under planning stage and the expected lube oil consumption by the project are shown in the table below.

	Lube Oil Consumption (lit./1,000ton*)			Expected Capacity in Thailand (ton/day)	Annual Production (297 days/ year)	Lube Oil Consumption (kl)			
	Engine Oil	Industrial Oil	Grease			Engine Oil	Industrial Oil	Grease	Total
Ammonia		0.465		900	267,300		124		124
Urea		0.270		1,000	297,000		80		80
Sulfuric Acid		0.150		2,180	647,460		65		65
Phosphoric Acid		0.230		720	213,840		49		49
Phosphate and compound Fertilizer	0.02	0.100	0.01	2,130	632,610	13	63	6	82
Total						13	381	6	400

Notes: * Based on Japanese experience

** Completion date: October 1986

Lube Oil Consumption in 1983 and 1993

	1983	1993
Engine Oil	0	13
Industrial Oil	0	381
Grease	0	6
Total	0	400

7-3 Rock Salt Project

(1) Rock Salt Production

Production: 1,800,000 ton

(2) Completion date: July 1985

(3) Lubricating oil consumption for salt project:

20% on total consumption is engine oil and 5% is grease (estimated by the Consultant from the experience in Japan).

(Unit: kl)

	1983	1993
Engine Oil	0	106
Industrial Oil	0	398
Grease	0	27
Total		531

7-4 Soda Ash Project

(1) Production: 400,000 ton/year

(2) Completion Date: July 1985

(3) Lube Oil Consumption: 139.7 kl

(Unit: kl)

	1983	1993
Engine Oil	0	28
Industrial Oil	0	111
Grease (ton)	0	0.7
Total		139.7

Note: 1) Estimated by the experience in Japan.

7-5 Petrochemical Project

	Lube[1] Oil Consumption (kl/1,000 ton)		Expected[2] Capacity (ton)	Lube Oil Consumption(kl)		
	Industrial Oil	Grease		Industrial Oil	Grease	Total
Ethylene	0.082	0.000355	300,000	25.0	0.01	25.01
Propylene			73,000			
LDPE	2.619	-	73,500	192.0	-	192.0
HDPE	0.0614	0.0020	110,000	7.0	0.23	7.23
VCM	0.125		80,000	10.0	-	10.0
EG	0.0089	0.00021	50,000	0.4	0.01	0.41
PP	0.002225	0.0056	70,000	1.6	0.39	1.99
				236.0	0.64	236.64

Notes: 1) Source: Estimated by the experience in Japan
2) Completion date: 1987

LUBRICATING OIL CONSUMPTION IN 1983 AND 1993

(Unit: kl)

	1983	1993
Industrial Oil	0	236.0
Grease	0	0.64
Total	0	236.64

7-6 Caustic Soda Project

Chlorine projection from caustic soda project meets to chlorine for vinyl chloride production.

Caustic soda production will be 55,000 ton/year, and completion date is in 1987.